

ZOOLOGY.—A new trichostrongylid nematode from the stomachs of American squirrels.<sup>1</sup> JOHN T. LUCKER, Bureau of Animal Industry.

The worms described in this paper were collected by L. Wayne Wilson from two squirrels (*Sciurus*) taken near Moorefield, Hardy County, W. Va., in November, 1941. Examination of the specimens revealed that they were trichostrongyloid nematodes, but it was immediately apparent that the males were very unusual, since certain of the bursal rays were observed to be chitinized.<sup>2</sup>

So far as the writer has been able to ascertain, the only trichostrongyloid nematode in which the occurrence of chitinized bursal rays has been reported is *Böhmiella perichitinea* Gebauer, 1932. Travassos,<sup>3</sup> in his extensive monograph on the Trichostrongylidae, agreed with Gebauer,<sup>4</sup> that, except in this genotype, chitinized bursal rays are unknown among the Strongyloidea.

The specimens collected by Mr. Wilson are here described as representing a new species, closely related to *B. perichitinea*, and for it the name *B. wilsoni* is proposed. While not admissible as evidence of zoological relationship, it is nevertheless of interest that both *B. perichitinea* and *B. wilsoni* are stomach worms of rodents. The known rodent hosts of the respective worms are not, however, closely allied species. *B. perichitinea* was found in a nutria or coypú, *Myocastor coypus*, in Germany. Whether it was introduced into Europe with the coypú, which is indigenous to South America, or normally occurs in European rodents is a question that as yet can not be answered, because there appears to be no subsequent report of its occurrence.

Although previously unrecognized, *B. wilsoni* evidently has existed in squirrels in

the southeastern United States for many years, since 4 females, undoubtedly the same as *B. wilsoni*, were found by the writer among specimens (U.S.N.M. Helm. Coll. no. 2934) collected by Dr. Albert Hassall from *Sciurus carolinensis* in 1897.

#### *Böhmiella wilsoni*, n. sp.

(Figs. 1-17)

*Description*.—Head small; diameter ( $40\mu$  to  $50\mu$ ) approximately the same as that of the adjacent cervical region. Lips absent; oral opening roughly circular; circumoral membrane present (Fig. 4). Amphidial pores and tips of ventrolateral papillae reaching cuticular surface adjacent to outer margin of circumoral membrane. Submedian papillae four in number, single, externally directed, their tips slightly protruding within depressions located slightly posterior to level of circumoral membrane. In *en face* view, semicircular strands of fibrillike nature may be seen extending outwardly from beneath margin of circumoral membrane to base of each submedian papilla; these strands apparently represent complete union and fusion of terminal branches of submedian papillary nerves. Margin of mouth opening apparently bearing superficially a row of extremely minute denticlelike structures which are interpreted as representing a weakly developed corona radiata (Fig. 4). Oral cavity very shallow, saucer-shaped; lining nonsclerotized. Esophagus communicating with buccal cavity by minute triangular opening and with a minute denticle, formed by lining of dorsal sector, protruding through opening into mouth cavity (Fig. 6). Esophagus swollen at anterior extremity; swollen portion histologically differentiated somewhat from tissue of remainder and partially surrounds mouth cavity (Figs. 3, 6). Cuticular covering of dorsal esophageal sector just posterior to minute terminal denticle forming a comparatively large, more or less transversely directed onchium with lumen and orifice at tip, presumably representing opening of dorsal esophageal gland, since a fine duct connecting with the lumen passes posteriorly into the tissue of the dorsal sector; tip of onchium not reaching floor of

<sup>1</sup> Received September 7, 1942.

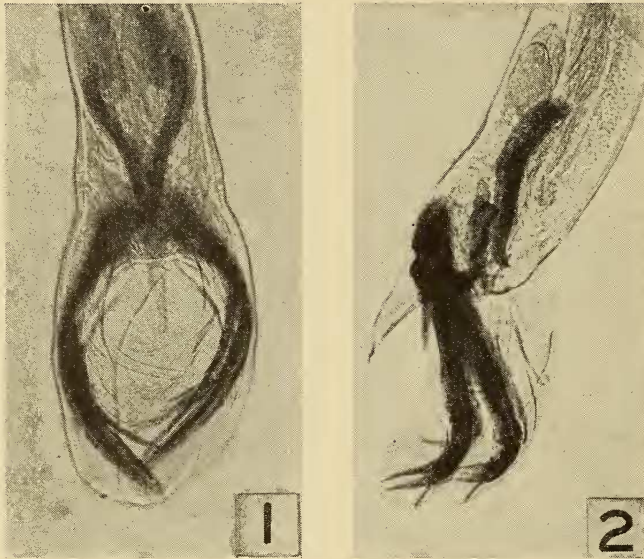
<sup>2</sup> In this paper derivatives of the noun chitin are used not in the chemical sense but as convenient descriptive terms to indicate the presence in the specified locations of a dense, brownish substance, probably similar to that composing the spicules of trichostrongylins and identical with it in appearance.

<sup>3</sup> TRAVASSOS, LAURO. *Revisão da família Trichostrongylidae* Leiper, 1912. Mongr. Inst. Oswaldo Cruz no. 1, 512 pp., 295 pls. 1937.

<sup>4</sup> GEBAUER, OTTO. *Böhmiella perichitinea* n. sp. ein neuer Trichostrongylide (Nematodes) des Nutria. Zeitschr. für Parasitenk. 4(4): 730-736, illus. 1932.

buccal cavity (Figs. 5, 6). Cuticular covering of each subventral sector of esophagus at level near base of onchium forming two minute, denticlelike, transversely directed eruptions; also forming rounded hyaline expansions at anterior extremity (Fig. 3). Cervical papillae, large, located slightly posterior to level of nerve ring; excretory pore between level of nerve ring and cervical papillae (Fig. 7). Lateral alae absent; cuticle of mid-body provided with about 50 longitudinal ridges.

deeper than that between the latter and left lateral lobe (Fig. 10). Ventral rays with common origin; directed posterolaterally for about two-thirds their length, curving anteriorly to bursal margin in their distal one-third, separated and somewhat divergent, but with their tips rather close together (Fig. 14). Ventroventrals smallest rays of lateral lobes, appearing as branches of lateroventrals, the latter having greater flexure than the ventroventrals and being the most robust of the bursal rays



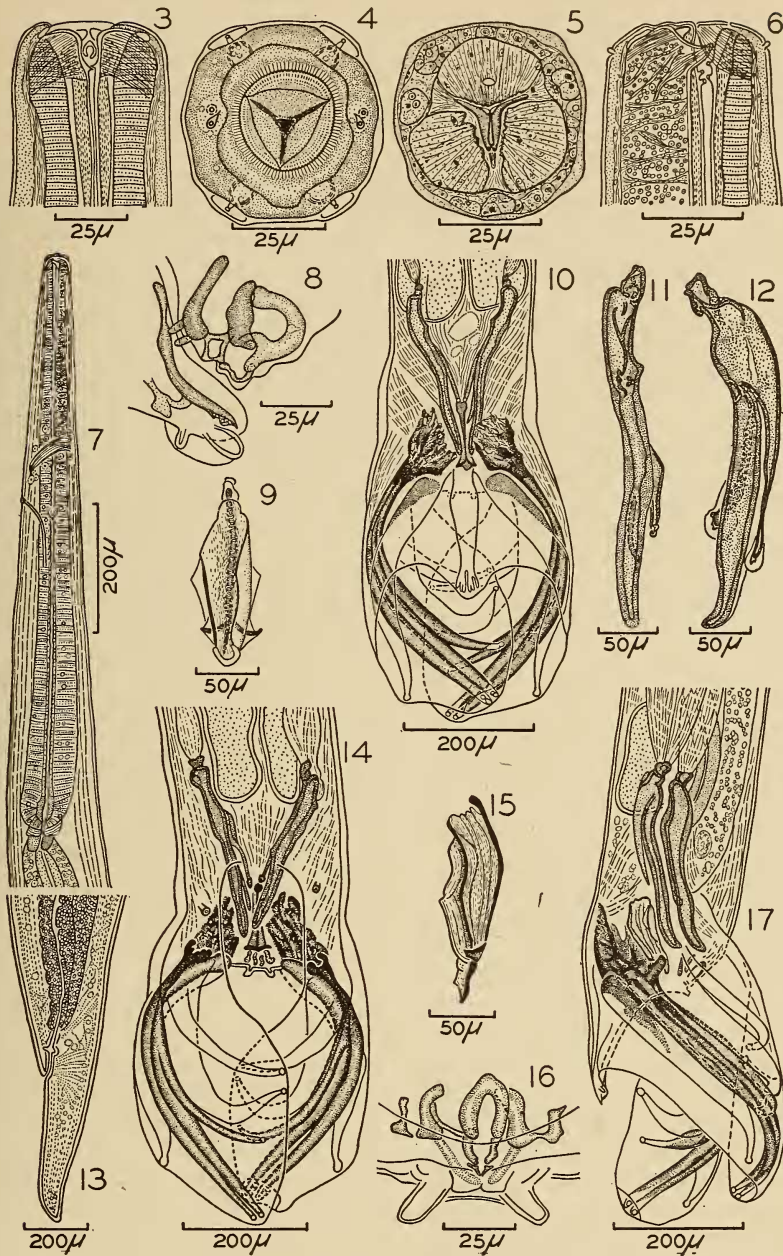
Figs. 1-2.—*Bohmiella wilsoni*, n. sp., caudal region of male: 1, Ventral aspect; 2, lateral aspect. (Photomicrographs; magnification approx.  $\times 80$ .)

*Male*.—In 3 available specimens 17.1 to 20.3 mm long by 0.21 to 0.24 mm wide just in front of bursa; esophagus, 0.84 to 0.94 mm long; distance from nerve ring and cervical papillae to anterior extremity, 0.32 to 0.35 and 0.43 to 0.45 mm, respectively; length of spicules, 0.300 to 0.321 mm; axial length of gubernaculum, 0.121 to 0.135 mm, length measured along curvature, 0.140 to 0.153 mm.

Prebursal papillae well developed (Fig. 14). Lateral bursal lobes roughly triangular with mediolateral and posterolateral rays supporting apex, originating near median ventral line of body surface a considerable distance anterior to genital cone, and with fine veinlike markings. Cleft between right lateral lobe and comparatively small dorsal lobe only slightly

(Figs. 10, 14). Laterals with common origin, comparatively slender, directed posterolaterally, except that externolaterals, which are parallel and contiguous to mediolaterals through most of their length, curve anteriorly away from the latter in distal one-third, so that their tips—which do not quite reach bursal margin—are considerably anterior to tips of mediolaterals (Figs. 10, 14, 17). Mediolaterals and posterolaterals equal, parallel, and contiguous, longer than externolaterals and other rays; tips close together, reaching bursal margin. Externodorsals more robust than laterals, but less robust than lateroventrals, apparently originating high up on stem of dorsal, parallel and contiguous to posterolaterals for most of length, but curving anterodorsally away from





Figs. 3-17.—*Böhmiella wilsoni*, n. sp.: 3, Anterior end (female), ventral aspect, optical section through dorsal onchium and two subventral esophageal teeth; 4, head (female), en face aspect; 5, optical cross section through esophagus in region of dorsal onchium, aspect in en face mount of head; 6, anterior end (female), lateral aspect, optical section through dorsal onchium and two pairs of subventral esophageal teeth; 7, esophageal region (male), lateral aspect; 8, telemon, lateral aspect; 9, gubernaculum, lateroventral aspect; 10, caudal region of male, dorsal aspect (chitinization represented by stippling); 11, right spicule, ventral aspect; 12, left spicule, ventro-lateral aspect; 13, caudal region of female, lateral aspect; 14, caudal region of male, ventral aspect (chitinization represented by stippling); 15, gubernaculum, lateral aspect; 16, telemon, ventral aspect; 17, caudal region of male, lateral aspect (chitinization represented by stippling, to simplify the figure only part of the left lateral lobe of the bursa is shown).

them distally so their tips, which reach the bursal margin, are considerably removed from the tips of the posterolaterals; length about same as externolaterals (Fig. 14). Dorsal ray much shorter than other rays, not asymmetrically located, straight; stem wide, bifurcate in distal one-fourth, each branch typically tridigitate but one may be bidigitate; ventral surface of stem without accessory branch (Fig. 10). Lateral rays with dense brownish chitinization at base and less dense chitinization extending nearly to tips, particularly along margins (Figs. 1, 2, 10, 14, 17). Externodorsal rays usually chitinized at base only (Fig. 10). In lateral view (Figs. 2, 17) chitinized tissues seen to extend internally and anteriorly from bases of these rays towards gubernaculum and anteriorly for a short distance along dorsal body wall, probably representing for most part modification of muscular tissues; in ventral view (Figs. 1, 14) these chitinized extensions appearing as a sort of median transverse bridge in region of spicule tips and gubernaculum. Genital cone with two submedian, thumblike, posteriorly directed processes. Spicules complex, brownish, consisting of complicated proximal knob and alate shaft and terminating distally in three processes, the longest representing a continuation of main shaft (Figs. 11, 12); proximal ends located laterally near body wall and in frontal plane; main shafts extending slightly dorsad and mediad in proximal two-fifths of length and rather sharply ventrad and mediad in distal three-fifths so tips reach median line in cloacal region (Figs. 1, 2, 10, 14). Shorter of two subsidiary distal prongs of each spicule originating from mediodorsal surface of main shaft, paralleling it and terminating in rather blunt, but digitate, medioventrally directed tip; remaining subsidiary prong originating from laterodorsal surface of main shaft, paralleling other prongs in most of length, usually curving dorsally away from them to rather sharp but digitate tip (Figs. 11, 12). Gubernaculum brownish, more or less boat-shaped, with very strongly chitinized dorsal keel ending proximally in knob and branching near distal tip to form pair of lateral crura (Fig. 9) reenforcing small dorso-lateral triangular alate projections, which merge with main lateroventrally directed wings (Fig. 15). In cloacal region light brownish chitinized structures, representing the telemon,

present; telemon grossly appearing in lateral view to be organized into three main sections, one lying along the posteroventral body wall, one along the lateroventral wall of the cloaca, and the remaining one along the laterodorsal wall of the cloaca (Figs. 2, 17), but consisting of a considerable number of more or less distinct, yet interrelated and apparently interconnected elements (Figs. 8, 16).

*Female*.—In 6 specimens 37.7 to 43.3 mm long by 0.40 to 0.58 mm wide at vulva; esophagus, 1.00 to 1.29 mm long; tail, 0.41 to 0.56 mm long; distance from vulva to posterior extremity 8.2 to 9.6 mm (ratio to body length, 1:4.1 to 1:4.7); eggs 88 to 105 $\mu$  by 50 to 62 $\mu$ . Tail digitiform, bent slightly dorsad at tip, without terminal spike or other cuticular or hypodermal modification (Fig. 13).

*Hosts*.—*Sciurus carolinensis leucotis*; *S. carolinensis*; *S. niger niger*.

*Location*.—Stomach.

*Locality*.—Moorefield, Hardy County, W. Va.; Virginia; Newton, Ga.

*Specimens*.—U.S.N.M. Helm. Coll. no. 36814 (holotype, male); no. 36853 (allotype); no. 36854 (paratypes, 1 male and several females); no. 45329 (removed from lot no. 2934); no. 42772.

*Remarks*.—The striking and readily observed character of ray chitinization is obviously one of great practical value in identification. The systematic importance, however, that should be attached to it is a question concerning which a consensus is not likely to be reached until specimens with chitinized rays have been more widely discovered and studied. Travassos<sup>5</sup> included *Böhmiella* in the Trichostrongylinae provisionally only and believed that further study of the bursa of the genotype might justify placing the genus in a separate major group. The writer does not regard ray chitinization as a fundamental morphological modification and believes that, by itself, the character should be assigned no more than specific value. It seems probable that this was Gebauer's<sup>6</sup> opinion also, since he did not propose *Böhmiella* simply because of the occurrence of this phenomenon. It is in a combination of characters that *B. perichitinea* appears to differ from other trichostrongylins sufficiently to warrant considering it a representative of a distinct genus.

<sup>5</sup> *Op. cit.*

<sup>6</sup> *Op. cit.*



The specimens here described are in many of their general features similar to *B. perichitinea* and are, therefore, regarded as representatives of the same genus. They differ in many respects, however, from the genotype as described by Gebauer and, therefore, are regarded as representing a new species.

It is conceded that certain of the described differences between *B. wilsoni* and *B. perichitinea* are of possible generic value. Notable among them are discrepancies in the number of cephalic papillae and in the nature of the buccal cavity and of the anterior end of the esophagus, and, corollary to the last, in the derivation, position, and orientation of the dorsal onchium and the denticles associated with it; also in this category are the presence in *B. wilsoni* of a circumoral elevation and a rudimentary leaf crown. However, the writer suspects that reexamination of the type specimens of *B. perichitinea* may reveal a closer similarity and relationship to *B. wilsoni* in these respects than now is evident.

In addition to the differences thus far alluded to, *B. wilsoni* is distinguished from *B. perichitinea* by presence of prebursal papillae and a telemon, absence of cervical alae, less marked inequality in the depth of the clefts between the dorsal and lateral lobes of the bursa, lack of dextral curvature and an accessory ventral rodlike process in the dorsal ray, longer spicules of different shape and orientation, larger gubernaculum, larger females with more anteriorly situated vulva, greater number of longitudinal cuticular ridges, shorter dorsal onchium, mediolateral and posterior-lateral rays longer than externolaterals, and lateroventral rays thicker than externodorsals. There also appear to be differences in the extent of the internal chitinized processes in the caudal region, notably, the absence in *B. wilsoni* of a narrow process extending between the spicules and the anterior extremity of the dorsal process, as well as absence of the pair of broom-shaped lateral processes, figured for *B. perichitinea*.

ZOOLOGY.—*Observations on the route of migration of the common liver fluke, Fasciola hepatica, in the definitive host.*<sup>1</sup> WENDELL H. KRULL and R. SCOTT JACKSON, U. S. Bureau of Animal Industry.

The essentials of the life history of the common liver fluke, *Fasciola hepatica*, have been known since 1882, when Thomas and Leuckart, independently, showed that the snail *Lymnaea truncatula* served as an intermediate host of this important parasite. In spite of these and subsequent investigations there still remain details concerning the development of the fluke in the intermediate and definitive hosts that have not been fully worked out. Important among these is the route of migration to the liver of the young fluke after its excystment in the digestive tract of the definitive host.

Three possible routes of migration have been postulated, namely, (1) direct migration from the intestine to the bile ducts through the hepatic duct; (2) passive transportation by the portal circulation after penetration of the intestinal mucosa, the young fluke gaining access to the bile ducts by perforation; and (3) penetration of the

intestine, active migration in the peritoneal cavity, perforation of the liver capsule, and migration through the liver parenchyma to the bile ducts. The first of these possible routes is the one most generally accepted, although it is the only one entirely unsupported by experimental evidence. On the other hand, Bugge (1935) concluded, on the basis of his examination of numerous infected calves, that the young flukes reached the liver via the portal system. Sinitsin (1914) demonstrated young flukes in the washings from the abdominal cavity of rabbits to which encysted cercariae had been administered and concluded that the flukes must reach the liver through active penetration of the liver capsule; this observation was supported by Shirai (1927). Sinitsin's theory was further supported by Shaw (1932), who injected larval flukes directly into the peritoneal cavities of rabbits, guinea pigs, and lambs and observed that the young flukes penetrated the hepatic

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